SCIENCE

NEW YORK, FEBRUARY 23, 1894.

SOME RECENT WORK ON CLAYS.[1]

BY G. PERRY GRIMSLEY, BALTIMORE, MD.

THE seventh volume of the Ohio Geological Survey, under the direction of Prof. Edw. Orton, which has just appeared, contains an extended and interesting chapter on the clay deposits and workings in that State. The work is primarily intended for the assistance of those actively engaged in this work, and many suggestions are given which will prove of great value; but here also will be found the only complete account of the process of manufacture of city paving materials.

Ten years have passed since the last published work on Ohio clays; in this interval there has been great expansion in the industry, and new features have been introduced. At the present time there are over twenty-five distinct lines of clay manufacture, and in most Ohio leads. In the sewer-pipe industry it stands foremost in amount of ware and in possession of three of the largest factories in the world.

Coal has always been regarded as Ohio's great source of mineral wealth, but where this is removed clay deposits are found which are greater sources of wealth than the original coal. Thus the Ohio coal measures are now becoming the clay measures.

The best clay must be free from calcium, iron and alkali bases, for if these be present they will act as fluxes, so destroying the clay as a refractory material. Since clay originates from minerals containing these elements, it is rare to find this high grade clay, and, when found, the deposits are most valuable.

There is no true scientific classification of clays, but they are popularly divided into clays and shales; the latter originated in deeper water and very often show no plasticity. A high grade clay is composed of kaolin and silica, while the poorer grades in addition have the fluxing elements.

It is found that nearly every coal seam is underlaid by a clay, locally called fire clay. In most cases it is everything but a fire clay and is used only in potteries.

Most of the true fire clays of Ohio belong to the non-plastic type. In this clay small microscopic bundles of rods are found, indicating incipient crystallization; it is thought the peculiar property of hard fire clay depends on this property, since there is no chemical difference between such a clay and a plastic one.

The lowest clays worked in the State are found at the base of the Upper Silurian, but they are only of local interest. The first important series to be worked is the great mass of Devonian black and blue shales at Columbus used in the extensive sewer pipe industry. The best clay in quality is found in the sub-Carboniferous Sciotoville clay used for fire brick.

The important clay industries of the State are based almost wholly on the coal measure clays and shales. Under and over the coal occur clay and shales.

The first of the Ohio coals has a roof of shales, which forms the basis of one of the largest sewer-pipe and roofing tile works in this country, located at Akron.

The Mercer clays, below the Mercer coals, are used in the manufacture of terra cotta and ornamental brick, while the Kittanning series support a second fire brick industry at Mineral Point.

In the Freeport horizon occur the clays and shales which are used so extensively in central Ohio for the manufacture of paving brick.

It would be interesting to follow out the development in the different lines, if space permitted, but only the new enterprise introduced in the last few years into this country will be reviewed. This whole subject has been most carefully investigated and described by Mr. Edw. Orton, jr., in this report.

Ten years ago shales were regarded as so much waste in the clay workings; now they are found to be of great value.

The difference between paving brick and common brick rests on the fact that the elements of the former have reached a state of fusion, and so are chemically united; while in the latter it is more the physical union of adhesion. The true test is absorption, which would be nothing in a perfect paving brick.

The clay must conform to certain conditions in order to yield a good paving brick. It must combine refractoriness with fusibility and must be sufficiently plastic to be easily worked. The amount of iron present determines the color of the ware and smoothness of surface.

An average of a large number of analyses shows the composition of a good paving brick to be 84.78 per cent clay and sand, 13.22 per cent fluxes. High heat is not required and if present ruins the product.

These shales have lost their natural plasticity, which must be regained. This is accomplished by grinding the dry material to a powder and tempering this to the proper consistency by the use of water.

The universal method of grinding in Ohio is by the use of a large revolving pan, with two heavy iron wheels moving in this. The clay is next carefully screened to varying fineness, usually the finer the clay the finer and more durable the brick.

The value of the ware depends most of all on the *tempering;* this is accomplished at the least cost by means of

[1] Geological Survey of Ohio, vol. vii., part i. Columbus, Ohio, 1893.

the well-known pug mill. By the use of this machine the mixture is rendered very uniform.

Of all the methods used for making the bricks, the best seems to be that of moulding the clay when in stiff condition. The clays in the stiff mud machines are tempered to a plastic state; when freshly made these bricks will retain their shape under considerable weight.

The machine most generally used is the Auzer machine, consisting of a revolving screw which carries the clay forward and forces it out of the die. It combines economy of handling with a saving of steam power. The great objection is a tendency of the machine to build the bar of clay out of concentric layers, especially in a very plastic clay. By the use of shales, this difficulty has been partially removed.

Automatic cut-off tables have been devised which dispense with the slow method of hand cutting. In a recent test 250 bricks per minute were cut and removed.

Re-pressing the bricks, which was once in great favor, is found to add nothing to their value, though the method is still used.

The bricks must be carefully dried to rid them of the large amount of water used in mixing the clays. They must finally be burned so as to possess the qualities of toughness, vitrification, and uniformity.

The cost of manufacture, including loss in burning, averages about seven dollars per thousand. The cost to cities averages fourteen dollars, which will probably be greatly reduced under better financial management.

There are at present in Ohio forty-four manufactories, with 357 kilns, making annually 292,000,000 bricks.

A PLEA FOR THE STUDY OF THE PHILOSOPHY OF MATHEMATICS.

BY FRANKLIN A. BECHER, MILWAUKEE, WIS.

IN early times mathematics and philosophy were kindred sciences. Mathematics was the essential study required to a preparatory entrance into the higher and more advanced branches of human knowledge. They were the complements of one another. Both set out with definite ends in view, yet the methods pursued were in some respects quite different. While the one assumed certain postulates to be true for the purpose of developing the science, the other was endeavoring to establish a principle upon which everything extant rested. The methods pursued were almost diametrically opposite. Mathematics developed in the direction from the particular to the general. It was not until the introduction of the idea of the function, by Euler, into mathematical reasoning that a more general method was possible. A philosophy of any science cannot be established until some well-defined general conceptions are developed. The philosophy of mathematics is no exception to this rule. Through the development of a more general method, the conceptions extended and became more universal; that which gave impetus to this was the introduction of the idea of the function. It was not long before the method of inquiry changed in this respect. Formerly higher algebra sought mainly to determine those values of functions for which they vanished, while modern algebra has for its problem to discover the peculiarity or nature of the function, regarding only incidentally the numeric value. The masters of modern higher algebra have gained thereby an opportunity to discover new thought-forms, which differ essentially from the old ones. These new thought-forms have aided much in suggesting many beautiful theorems and problems which again have led up to new discoveries. The progress made has been with giant strides, so that many fundamental conceptions and propositions are fast losing their validity. It is but within recent times that the conception manifoldness was introduced into mathematical reasoning by Riemann. This conception sheds light over the whole field of mathematics, and therefore has aided in establishing a foundation for a philosophy of mathematics. The essentials to a philosophy of the science are well stated by Grassmann, who says: "Since both mathematics and philosophy are sciences in the strictest sense of the terms, the methods employed in each must accordingly have something in common, which gives them their peculiar scientific character. Now, we give a scientific character to a method of treatment when the student, on the one hand, is of necessity led by it to the recognition of every single truth, and on the other hand is placed in a position wherefrom he is enabled, at every point in the development, to survey the course of further progress." Here we have the importance shown of having some central conception or conceptions, from which we can view the whole field. The men and their works that have contributed to establishing these general methods and conceptions, thereby laying a foundation for a philosophy of mathematics, are: Grassmann, in his "Ausdehnungslehre" (Hyde's Directional Calculus); Hamilton, in his "Quarternions"; Pierce, in his "Linear Associative Algebra," and Cantor, in his "Mannigfaltigkeitsrechung," the most important work from a philosophical standpoint.

Few, if any, of our universities seem to devote any time to the study of the philosophy of mathematics, and there are only a small number that embody any of the above named subjects in their curricula. In fact, it is only very recently that our modern text-book writers have deviated from the trodden path and introduced some of the more advanced notions in their works. It is only within a few months that a new and excellent treatise, the first in this country, on the "Theory of Functions," by Harkness and Morley, has appeared. Why most of our mathematical text-book writers, like lawyers, have a strong inclination to adhere to old musty forms and ways of presentation is difficult to perceive.

The importance of the study of the philosophy of mathematics is beyond all question. A knowledge merely of the objective side of any subject is not only detrimental to its presentation, but a thorough knowledge of the subject can never be obtained. It is like the bones and muscles to the human body without the nerves. Again, if these subjects are not taught which lead up to the philosophy of mathematics, so that a consistent, true and proper view can be had of the entire field of this knowledge, a teaching of this branch is fruitless. The study of all the fundamental principles of these subjects and the study of the philosophy of mathematics ought to be thoroughly mastered by every one who aspires to have an accurate knowledge of the subject and wishes to become a mathematician.

—J. B. Lippincott Company announce as an addition to their extensive list of medical books a new volume entitled "Pain," by J. Leonard Corning, A.M., M.D. The author has made a specialty of the study of this important subject, and holds that there is no department of neurology a knowledge of which is so essential to the physician.